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ABSTRACT

The literature review identifies information regarding the emergence of mobility skills in infants and young handicapped children, including rolling, crawling, creeping, and walking. Sections discuss the following topics: assessment instruments relevant to mobility, the identification of developmental milestones in mobility, and a hierarchy of the development of mobility skills that represents a synthesis of the literature reviewed. Standardized instruments reviewed are the Developmental Profile, the Bayley Scales of Infant Development, the Denver Developmental Screening Test, the Developmental Schedules, and the Koontz Child Development Program; while the nonstandardized instruments reviewed are the Down's Syndrome Inventory, the Developmental Pinpoints, the Infant Learning Program Behavioral Repertoire, the Learning Accomplishment Profile, the Behavioral Characteristics Progression, the Callier Azusa Scale, the Portage Project Checklist, and the Project Memphis Checklist. It is explained that assessment instrument information made it possible to identify mobility behaviors, behaviors preceding mobility, and ages ascribed to those behaviors. (SB)

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REVIEW OF MEASUREMENT INSTRUMENTS AND PROCEDURES FOR ASSESSING MOBILITY BEHAVIORS: IMPLICATIONS FOR QUANTITATIVE MEASUREMENT

by

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MOBILITY

This review of the literature was undertaken for the purpose of identifying existing information regarding the emergence of mobility skills in infants and young handicapped children, including rolling, crawling, creeping and walking. Specific information was sought relating to the documentation of the emergence of mobility skills, the instruments and procedures used to identify and assess these skills, and the research that has been conducted to identify the sequence and ages of the emergence of mobility.

In all of the materials reviewed, the basic references go back to earlier studies by Gesell (1928), Gesell and Armatruda (1941), McGraw (1940, 1941, 1943), and Shirley (1933). Their previous longitudinal studies in infant development had apparently provided the basis for most if not all subsequent work in the area of mobility.

This review will discuss 1) assessment instruments relevant to mobility; 2) the identification of developmental milestones in this area; and, 3) a proposed hierarchy of the development of mobility skills that represents a synthesis of the literature reviewed.

Standardized Instruments and Checklists

Instruments and developmental checklists were selected for review in this section if they met the following criteria: 1) items were included relating to mobility between the ages of birth to twelve months; 2) behaviors were referenced to a hypothesized sequence of emergence; 3) behaviors were defined in observable terms; and, 4) the instruments underwent standardization procedures. Each of the instruments was reviewed to determine the specified testing con-

ditions (including settings, materials, time limitations), clarity of the behavioral descriptions, and scoring procedures utilized. The instruments reviewed were: The Developmental Profile (Alpern and Boll, 1972), The Bayley Scales of Infant Development, (Bayley, 1969), The Denver Developmental Screening Test, (Frankenburg, Dodds, and Fandal, 1975), The Developmental Schedules (Gesell, 1928; Gesell and Thompson, 1934; and Gesell and Amatruda, 1941), and the Koontz Child Development Program (Koontz, 1974).

Many of the instruments reviewed did not include specifications regarding the physical environment during the examination or observation period. The Bayley Scales of Infant Development and the Developmental Schedules provided the most information. Included in the Bayley Scales were specifications for the equipment required in positioning the child, suggestions regarding the appearance of the examining room, and the dress of the examiner. The Developmental Schedules included blueprints for special equipment to be used, recommended room arrangements, and appropriate positioning of the child and observer in relationship to the room and to each other. A special emphasis was made by Gesell on the need for the standardization of these procedures. The Denver Developmental Screening Test did not describe any physical conditions required for testing procedures. Similarily the Development Profile and the Koontz Child Development Program did not require the use of particular physical arrangements. (Both of these instruments utilize parental report and observation).

Most of the manuals for the instruments included at least a brief discussion of the arrangement of the environment to maximize the child's performance during the examination period. The Bayley Scales described

a number of suggestions to accomplish this, including assistance by the mother or mother-substitute. The Developmental Schedule described introductory procedures specific to various ages. The Denver Developmental Screening Test briefly discussed the need to make the child comfortable during the examination period and include a few suggestions to accomplish this.

Very detailed procedures were included in the Developmental Schedules for the assessment of individual skills. The sequence of the assessment prescribed depend upon the child's chronological age. Then, for each of the mobility items, instructions were provided regarding what behaviors are to be observed and how to encourage the demonstration of that skill. Each behavior was elicited and observed in a variety of ways dependent on the child's demonstration of behaviors in preceding assessment situations. Suggestions were given for methods of positioning children to maximize performance. The type and placement of "lures" to encourage movement was also discussed.

The Bayley Scales included brief descriptions of the position in which the infant should be placed for each behavior. Sidelying and supine positions were used to assess rolling and the prone position was used to assess crawling and creeping. For standing and walking, the position of the child was not specified. The Denver Developmental Screening Test included specifications for positioning the child for some items; others were scored by report of the parent. The Developmental Profile and the Koontz Child Developmental Program included conditions in their questions that sometimes specified the desired position of the child to demonstrate the skill; i.e., "...when on

a hard surface, on stomach, child will make alternating movements of legs," (Koontz, 1974, p. 8).

While initial positioning of the child was described in most of the instruments for most of the behaviors, no suggestions were made regarding the use of an orthosis or prosthesis, or the observations to be made in this situation. No recommendations were noted regarding the degrees of physical assistance in positioning by the examiner and that effect on scoring. In each assessment, creeping behaviors were observed after placing the child in prone; none assessed creeping behavior after the child was placed in a creeping position. Behaviors in all instruments were assessed on flat surfaces such as floors or crib mats. No measures of mobility on inclined or carpeted surfaces were recommended.

The only materials described in the assessment of mobility skills were those used to attract the child and to encourage movement. Toys were the most frequent recommendation.

The scoring procedure used by each of the instruments was the recording of the presence or absence of the skill for each item described. In few cases did the behavioral description include a quantifiable specification of when a skill should be considered "present" in terms of duration, latency or rate. The Bayley Scales included only one distance qualification in creeping and crawling; the Developmental Schedules indicated pivoting in prone must be more than 45°. The Koontz Child Development Program qualified standing as "standing unsupported for several seconds." The only quantifications in the Denver Developmental Screening Test were a two and ten second duration measure of unsupported standing, and a five second duration measure

of supported standing. No such quantifications were included in the Developmental Profile.

The Developmental Schedules were the most structured of the instruments reviewed in terms of the requirement for the actual observation by the examiner of the assessed beaviors. The Developmental Profile was scored totally by parental reports; the Koontz Child Developmental Program was scored after a minimum of one week of free observation. Both the Denver Developmental Screening Test and the Bayley Scales used a combination of structured examination, observation, and parent report.

All of the instruments reviewed included four types of mobility: rolling, crawling, creeping and walking. Differences occurred in the number and kind of observations made for each type of mobility. The more detailed assessments such as the Bayley and Developmental Diagnosis included component behaviors related to each type of mobility, i.e., arm positions related to creeping behaviors. The others did not break down each skill as finely. None of the instruments rated degrees of performance of the task in terms of quality of the movement, e.g., uncoordinated or smooth.

Non Standardized Instruments and Checklists

Many non-standardized instruments and checklists are available which also identify and measure the existence of mobility skills. The instruments selected for review were based on the following criteria: 1) they included items related to mobility between the ages of 0-12 months; 2) behaviors were referenced to a hypothesized sequence of emergence; and, 3) behaviors were defined in observable terms. The instruments varied greatly in the clarity of the behavioral

definitions, the conditions prescribed for the examining situation, and the materials used. The instruments reviewed were: The Down's Syndrome Inventory (Note 1), the Developmental Pinpoints (Cohen, Gross and Haring, 1976), The Infant Learning Program Behavioral Repertoire (Note 2), The Learning Accomplishment Profile (Sanford, 1974), The Behavioral Characteristics Progression (Santa Cruz County Department of Education, 1973), The Callier Azusa Scale (Note 3), the Portage Project Checklist (Note 4), and the Project Memphis Checklist (Quick, Little and Campbell, 1974).

Most frequently, the setting for administrating the assessment was less structured than for the standardized instruments. Of the eight instruments included in the review, five used examiner observation. The Developmental Pinpoints, Project Memphis Checklist, and Portage Project Checklists specified that the recording should occur after observation of the child, but the period of observation time was not specified. The Behavioral Characteristics Progression and Callier Azusa recommended classroom observation periods of at least two weeks. The Infant Learning Program Behavioral Repertoire and the Down's Syndrome Inventory employed more formal procedures and utilized contrived settings to assess the skills.

All of the instruments included at least brief descriptions of the procedures used to assess, or the conditions for the observation of, individual skills. The Infant Learning Program Behavioral Repertoire included the most detailed instructions to the examiner regarding the procedures to be used to elicit target responses. Included for each skill were statements regarding the positioning and handling of the child. Particular types of surfaces or furniture

were also specified when needed. The Learning Accomplishment Profile derived all mobility items under one year of age from the Denver Developmental Screening Test, Bayley Scales of infant Development and Development Schedules. As in the original sources, some of the items included directions for positioning the child and observing the responses. Other items were again scored by parental report. The Callier Azusa, Behavioral Characteristics Progression, Portage Checklist and Project Memphis Checklist did not clearly identify the way in which the examinations or observations should be conducted. However, the positioning and materials necessary are easily inferred from the behavioral descriptions, i.e., "on stomach, rolls from side to side" (Stillman, Note 3, p. 11) or "maintains self in a crawling position" (Dmitriev, Note 1, p. 11). For most of the items, it was not anticipated that this lack of specific definitions would pose a major problem. However, it is possible that some of the mobility skills could be performed with the assistance of a person, orthosis, or prosthesis. In most cases no suggestions were made regarding the rating or score to be recorded in such a situation. The exception to this in all assessments is the assistance provided the child in pulling to standing and walking. Additionally the Infant Learning Program Behavioral Repertoire included an item in which creeping is assessed after the child was placed in a hands and knees position.

The scoring procedures used in all of the non-standardized instruments were occurrence measures. Only the Learning Accomplishment Profile included any quantitative clarifications of items scored. Only "standing alone" and "standing with support" were measured by

duration in that instrument. The Developmental Pinpoints, Portage Checklist, Behavioral Characteristics Progression, Callier Azusa, Memphis Checklist and Infant Learning Program Behavioral Repertoire included no such qualifications. Descriptors such as "momentarily," "temporarily" and "briefly" were used.

The instruments reviewed varied greatly in the number of items included to assess mobility skills and the categorization of those items. All, however, assessed the four mobility types of rolling, crawling, creeping, and walking. The Developmental Pinpoints included the largest number of items to assess in the areas of "maintaining static balance and maintaining dynamic balance using basic movement patterns." The Infant Learning Program Behavioral Repertoire included items in "prone progression" and "upright" categories. In addition to assessing rolling, crawling, creeping, and walking, this instrument assessed associated reflexive behaviors, including the asymmetrical tonic neck reflex and the tonic labyrinthine reflex. The Callier Azusa categorized relevant mobility behaviors into "postural control and locomotion." As in the other instruments, the four types of mobility were assessed but additional responses were included in which the examiner was directed to omit "only if the child cannot be expected to exhibit the behavior because of a specific sensory or motor deficit" (Stillman, Note 3, p. 4). The Learning Accomplishment Profile, Down's Syndrome Inventory, Memphis Checklist and Portage Guides arranged the assessment items by age and the Behavioral Characteristics Progression listed the skills in a generally sequential order by age (although no ages were recorded on the form). The number of mobility skills assessed in

the instruments reviewed ranged from five in the Memphis Checklist to 41 in the Developmental Pinpoints.

Basic Research in Development of Mobility Skills

Most of the research related to the identification of the sequence of the development of mobility skills occurred between 1920 and 1950. The early work of Gesell seems to have had the largest impact. Frequently referenced norms from Gesell, (Gesell, 1928, 1940; Gesell and Amatruda, 1941; Gesell and Thompson, 1934, 1938) were derived from a study of 107 children. Five hundred and twenty four examinations were conducted at four week intervals during the children's first year of life. Mobility skills were assessed via the Developmental Schedules developed by Gesell. Norms were determined by calculating the percentage of children displaying a behavior at each age level and are reported in Infant Behavior (Gesell and Thompson, 1934). Data were stenographically and cinemagraphically recorded.

Reliability was reported for only prone behaviors. Reliability was calculated by comparing the percentage of occurrence of items for each age level for two different groups of children. Each group of children was assessed by different examiners. Reliability was reported to be 90% or higher for 54% of the items assessed in prone.

Gesell is credited with pioneering use of cinematography to document behaviors in infants. Sixteen millimeter film of mobility behaviors was hand projected, enabling stop-frame analysis of the film to determine duration and topography of individual behaviors. With this procedure Gesell was able to identify and analyze movement of the head, trunk, arms, legs, hands, and feet associated with mobility.

Of the research reviewed (McGraw 1941, 1943; McGraw and Breeze, 1941) provided the most detailed analyses of the development of mobility skills. Utilizing cinematography along with other procedures, several studies were completed in the areas of rolling, crawling and creeping, erect locomtion, stepping, and erect posture. For each of the areas, progressions and modal ages were identified. In studying crawling and creeping, McGraw observed 82 infants at weekly and bi-weekly intervals. A total of 1777 observations were made. Four hundred and twenty-two observations were recorded on motion film and 1135 were recorded as written protocol. From the films, detailed drawings of the progressions were prepared to illustrate the topography of these behaviors. Utilizing the observations, the phases of prone progression were identified. Descriptions of each phase were provided by McGraw and are summarized in Figure 1. These phases were organized into data sheets enabling observers to record the presence or absence of overt behaviors related to the prone progression. The data were summarized by computing the percentage of occurrence for each phase for 10 day intervals at each chronological age level. The resulting data showed the range of emergence, completion of the phase, and corresponding modal chronological ages. Reliability data were obtained after the initial observations were completed by McGraw. A series of films were shown to groups of 13 and 42 observers. The films showed 31 different behaviors of infants. The reliability coefficient for the 13 observers was 84.4% and 75.5% for the group of 42.

Three thousand, three hundred and eighty-seven observations

A Newborn - characterized by total body flexion, face resting on surface, occasional head bobbing, flexed upper and lower extremeties.

A Beginning Spinal Extension - baby lifts head for a while less flexion shown in upper extremeties.

C Advanced Spinal Extension - baby lifts head and chest, supports self on arms.

D Incipient Propulsion in Superiod Region - demonstrates attempts to move by extended arm forward.

E Incipient Propulsion in Inferior Region - baby raises hips by extending legs.

F Assumption of Creeping Posture - baby maintains abdomen in a raised position.

G Deliverate but Unorganized Progression - movement forward but not smooth.

H Organized Progesss - smooth coordinated movements forward.

I Integrated Progression - demonstrates synchronization of left arm/right leg movements.

FIGURE 1. MCGRAW'S PRONE PROGRESSION

Adapted from McGraw, M. Development of neuro-muscular mechanics in the crawling and creeping behavior of the human infant. Journal of Genetic Psychology, 1941, 58, 83-111.

were made of eighty-two children by McGraw and Breeze (1941) to determine the sequence of the development of the assumption of erect posture and walking. The ages of the children studied ranged from a few months to eight years old. Through the same method described previously various stages were identified. They are summarized in Figures 2 and 3.

Shirley (1941) did a longitudinal study of 25 babies during their first two years of life. Data were obtained through daily records by the mothers of the children in the study and by standardized motor tests administered bi-weekly. In the daily recording procedures, mothers were requested to check a developmental skill appearing on a checklist on the first day the particular behavior was demonstrated and to continue checking that item (if it occurred) for two weeks. It was reported that the checked item was included in the study only if the examiner concurred with the parent. No reliability information was reported in this study.

Shirley (1941) has provided detailed reports of other procedures used to quantitatively measure the development of crawling and walking. For the creeping progession, latency and duration of the responses as well as the distance traversed were measured. None were considered to be satisfactory by Shirley. Reasons for this included variations in responses resulting from motivational differences in the children, (i.e., how interested the children were in getting someplace). In the study of how children assume an erect posture, the duration of standing behavior was recorded as well as the latency of getting to a standing position. Begin-

A Newborn or reflex stepping - general flexion, organized stepping.

B Inhibition or Static Phase - no demonstration of stepping.

C Transition - more movement of body, stamping of feet, stamping possibly reflexive.

D Deliberate Stepping - maintains a more errect position, stepping provoked by infant's hands held and support provided under arms.

E Independent Stepping - independent walking, gait wide, movements exaggerated.

F Heel - toe progression - steps become heal forward, foot strikes the surface as back foot is raised on toes.

G Intergration or Maturity of Erect Locomotion - synchoronous swinging of each arm coordinated with movement of opposite lower extremity.

FIGURE 2. MCGRAW'S STEPPING PROGRESSION

Adapted from McGraw, M., and Breeze, K. Quantitative studies in the development of erect locomotion. Child Development, 1941, 12, 267-304.

A Passive Phase - passive to attempts to be pulled to standing.

B Extensor-Thrust Phase - attempts to stand when pulled to sitting.

C Orthotonic Phase - attains semi-erect position when pulled to sitting.

D Vertical Posture Phase - attains erect position when pulled to standing.

E Vertical Push Phase - attains erect position by holding on to furniture.

F Independent Rising Phase - awkwardly raises to erect position from floor.

G Integrated Phase - attains standing position from floor with coordinated movements.

FIGURE 3. MCGRAW'S ASSUMPTION OF AN ERECT POSTURE

Adapted from McGraw, M. Neuromuscular development of the human infant as exemplified in the achievement of erect locomotion. Journal of Pediatrics, 1940, 17, 747-771.

ning with the fifth month of age, weekly and sometimes bi-weekly measures were made of walking behavior by permanently recording foot steps of children. This was accomplished by applying oil to the feet of the children and having them walk across white wrapping paper. The recorded measures included the total number of full foot prints, toe prints, side prints, distance traversed, print sequence, stepping distance, stepping width and stepping angles. Medians and means for the group at each age level was calculated.

Ames (1937) studied the sequential pattern of the development of prone behaviors. Five children were studies for one year. Motion pictures taken at four week intervals recorded the children's behavior in four situations: in prone; in prone with an immobile, silent lure; in prone with a moving lure; and in prone with social interactions provided. Through the cinemographic analysis, 14 stages of prone progession were identified.

Developmental Sequence of Mobility

The literature relating to mobility was reviewed to identify behaviors leading to the emergence of mobility and the sequence of the emergence of those behaviors. The intent was to identify a sequence of behavior that was observable and could be assessed by quantitative measures.

Utilizing information obtained from assessment instruments (both standardized and nonstandardized) and developmental research, it was possible to identify 1) mobility behaviors; 2) behaviors preceding mobility; and, 3) ages ascribed to those behaviors. Behaviors and corresponding ages (when given) were recorded on indi-

vidual index cards. The cards were then sorted by the four general types of mobility - rolling, crawling, creeping and walking. By analyzing the grouping of cards in each category, it became evident that within each group several sub-categories were present. Those subcategories were: 1) movement into the position required for that type of mobility, i.e., child assumes all fours position; 2) stability in the position, i.e., child maintains all fours position for a period of time; 3) movement in the position, i.e., child rocks in all fours position; 4) locomotion in the position, i.e., child creeps; and, 5) movement out of the position, i.e., child goes from all fours position to prone. For each type of mobility the behaviors were similarily subcategorized.

Each category and subcategory was then reviewed with regard to the ages referenced. Each behavior was found to be identified with a range of ages, both within and among the various sources. For the purpose of summarizing this information, ages were used that represented the modal age identified by the sources reviewed.

A hierarchy was then constructed including only observable behaviors associated with mobility. Each type of mobility was arranged horizontally by the sequence in which the behaviors would be expected to be observed in a competent locomotor. The behaviors are arranged vertically by the age range of emergence. The mobility hierarchies can be viewed in Figures 4, 5, 6, & 7.

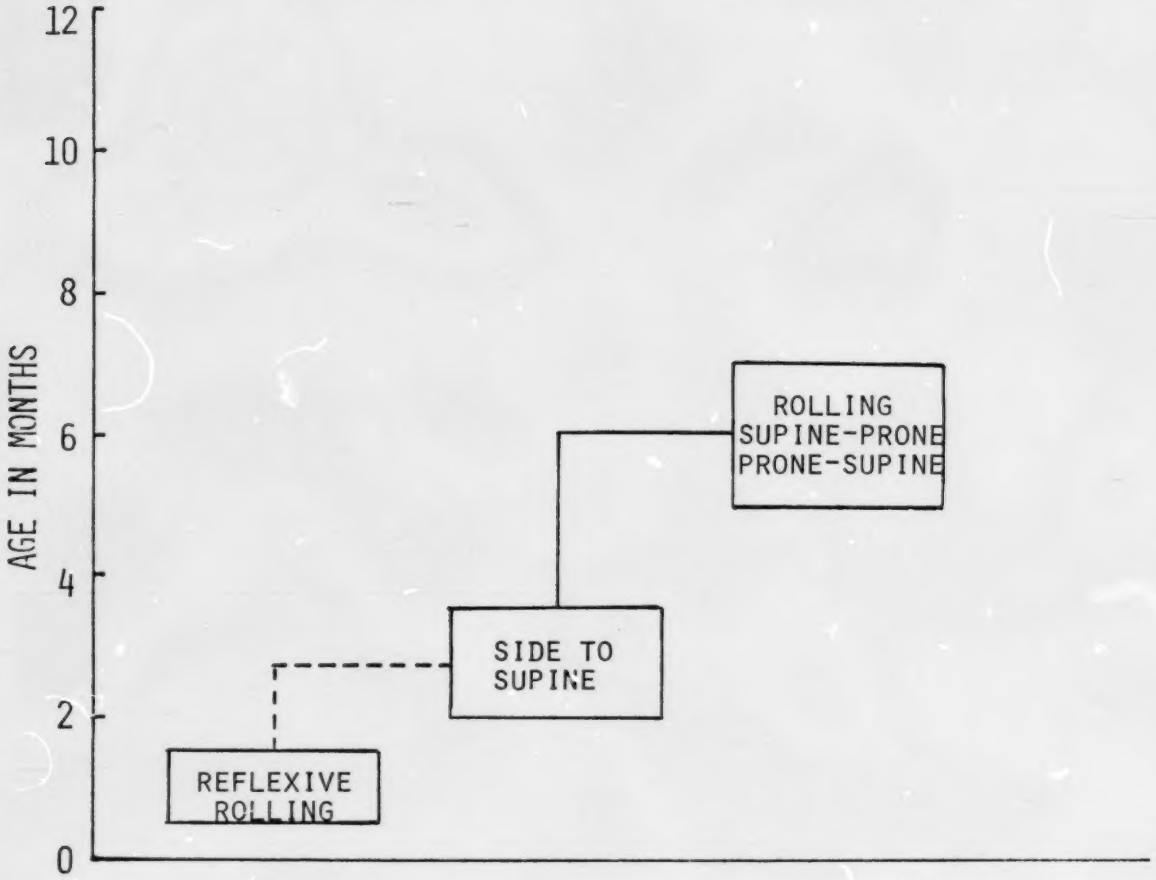

FIGURE 4 - ROLLING PROGRESSION

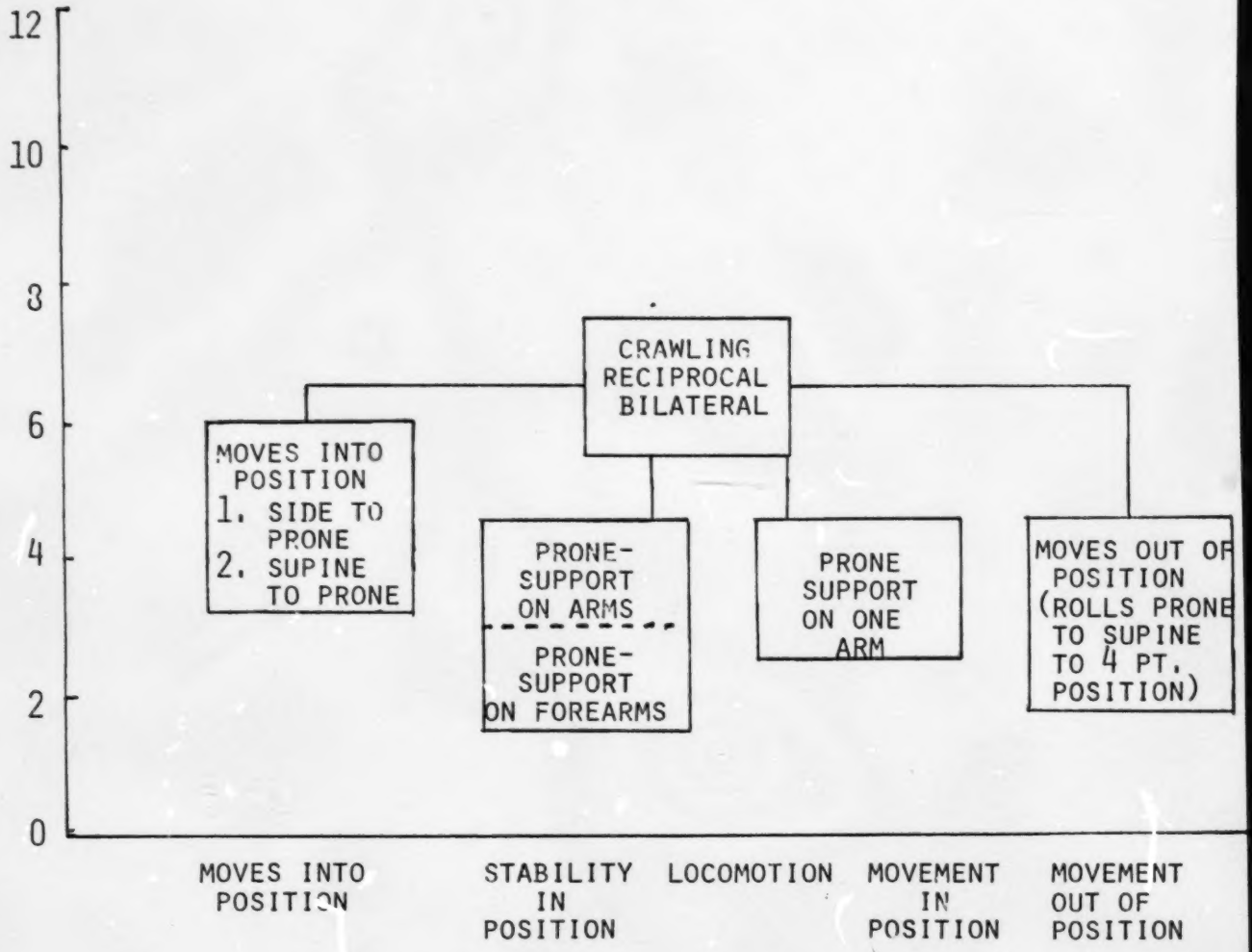

FIGURE 5 - CRAWLING PROGRESSION

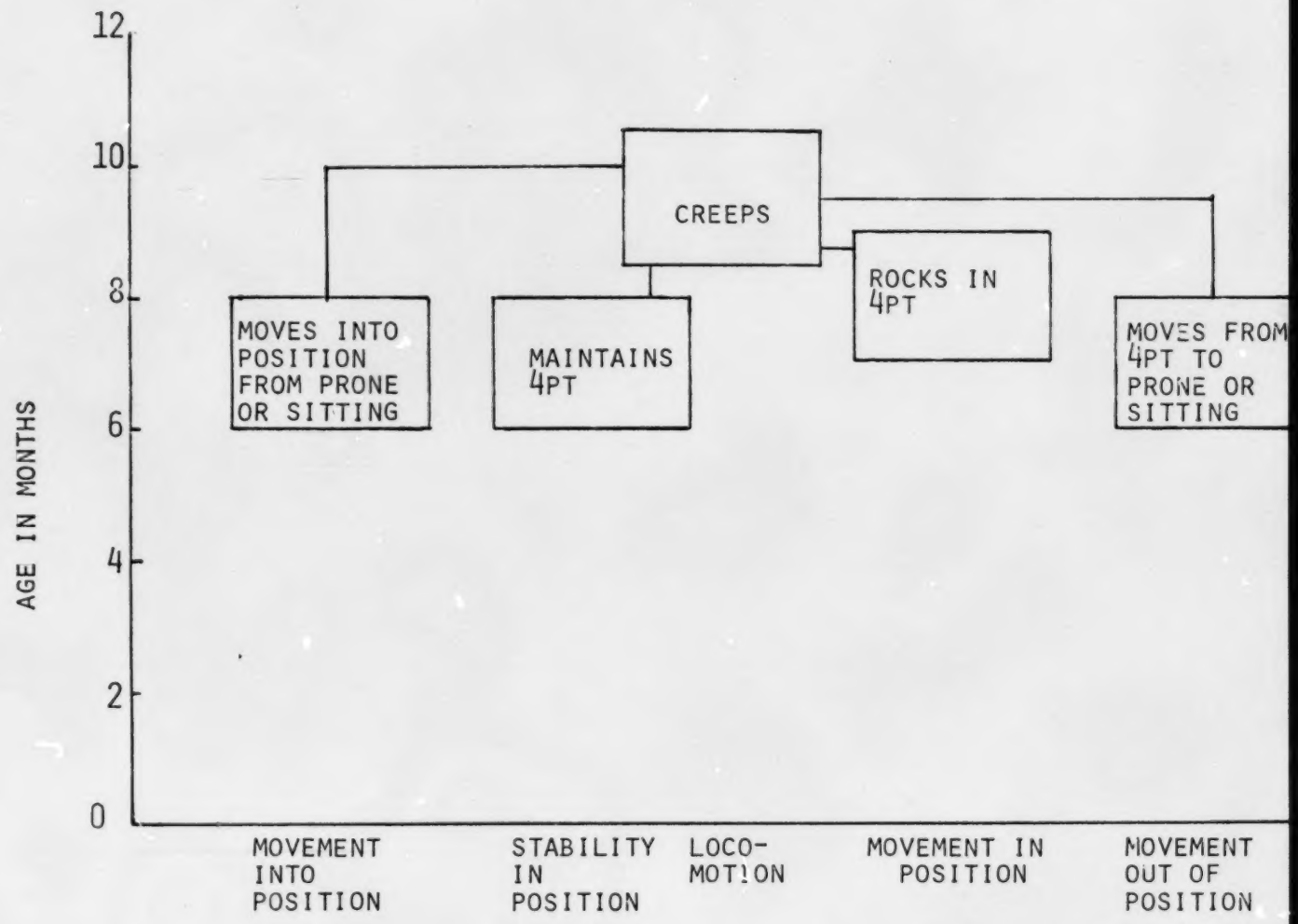

FIGURE 6. CREEPING PROGRESSION

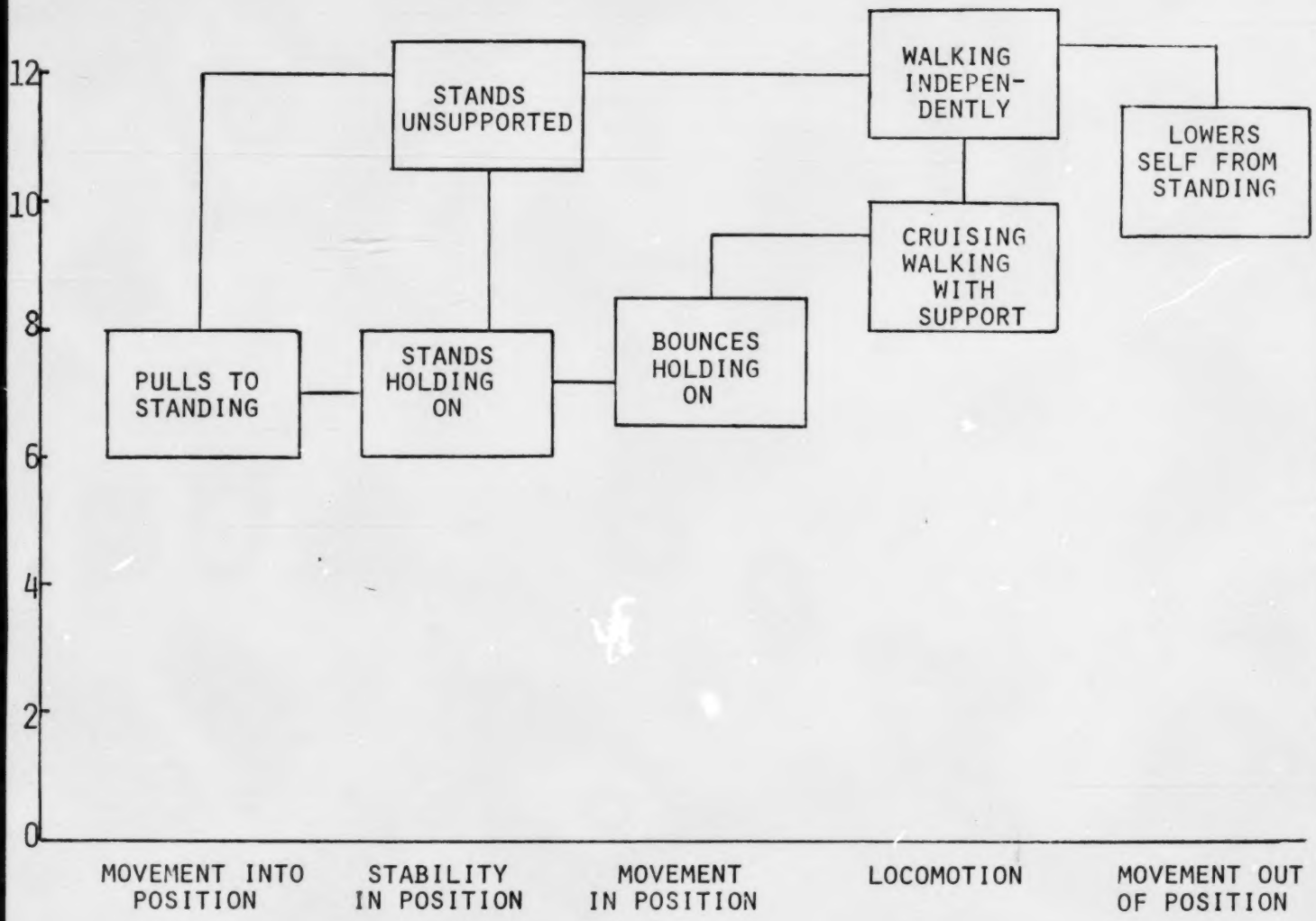

FIGURE 7 - WALKING PROGRESSION

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